

## PATENT COOPERATION TREATY

PCT/RU2006/000152

From the INTERNATIONAL BUREAU

**PCT**NOTIFICATION CONCERNING  
TRANSMITTAL OF COPY OF INTERNATIONAL  
PRELIMINARY REPORT ON PATENTABILITY  
(CHAPTER I OF THE PATENT COOPERATION  
TREATY)

(PCT Rule 44bis.1(c))

To:

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Date of mailing (day/month/year)

09 October 2008 (09.10.2008)

Applicant's or agent's file reference

2420-300727 *PA. 042*

## IMPORTANT NOTICE

International application No.

PCT/RU2006/000152

International filing date (day/month/year)

30 March 2006 (30.03.2006)

Priority date (day/month/year)

Applicant

INTEL CORPORATION et al

The International Bureau transmits herewith a copy of the international preliminary report on patentability (Chapter I of the Patent Cooperation Treaty)

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# PATENT COOPERATION TREATY

# PCT

## INTERNATIONAL PRELIMINARY REPORT ON PATENTABILITY

(Chapter I of the Patent Cooperation Treaty)

(PCT Rule 44bis)

Applicant's or agent's file reference 2420-300727	FOR FURTHER ACTION		See item 4 below
International application No. PCT/RU2006/000152	International filing date ( <i>day/month/year</i> ) 30 March 2006 (30.03.2006)	Priority date ( <i>day/month/year</i> )	
International Patent Classification (8th edition unless older edition indicated) See relevant information in Form PCT/ISA/237			
Applicant INTEL CORPORATION			

1. This international preliminary report on patentability (Chapter I) is issued by the International Bureau on behalf of the International Searching Authority under Rule 44 bis.1(a).

2. This REPORT consists of a total of 7 sheets, including this cover sheet.

In the attached sheets, any reference to the written opinion of the International Searching Authority should be read as a reference to the international preliminary report on patentability (Chapter I) instead.

3. This report contains indications relating to the following items:

- |                                     |              |   |
|-------------------------------------|--------------|---|
| <input checked="" type="checkbox"/> | Box No. I    | Basis of the report   |
| <input type="checkbox"/>            | Box No. II   | Priority  |
| <input type="checkbox"/>            | Box No. III  | Non-establishment of opinion with regard to novelty, inventive step and industrial applicability  |
| <input type="checkbox"/>            | Box No. IV   | Lack of unity of invention  |
| <input checked="" type="checkbox"/> | Box No. V    | Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement |
| <input type="checkbox"/>            | Box No. VI   | Certain documents cited   |
| <input type="checkbox"/>            | Box No. VII  | Certain defects in the international application  |
| <input type="checkbox"/>            | Box No. VIII | Certain observations on the international application   |

4. The International Bureau will communicate this report to designated Offices in accordance with Rules 44bis.3(c) and 93bis.1 but not, except where the applicant makes an express request under Article 23(2), before the expiration of 30 months from the priority date (Rule 44bis.2).

The International Bureau of WIPO 34, chemin des Colombettes 1211 Geneva 20, Switzerland  Facsimile No. +41 22 338 82 70	Date of issuance of this report 30 September 2008 (30.09.2008)  Authorized officer  <div style="text-align: center; font-weight: bold;">Beate Giffo-Schmitt</div>  e-mail: pt03.pct@wipo.int
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# PATENT COOPERATION TREATY

From the  
INTERNATIONAL SEARCHING AUTHORITY

## PCT

To:

see form PCT/ISA/220

### WRITTEN OPINION OF THE INTERNATIONAL SEARCHING AUTHORITY (PCT Rule 43bis.1)

Date of mailing  
(day/month/year) see form PCT/ISA/210 (second sheet)

Applicant's or agent's file reference  
see form PCT/ISA/220

**FOR FURTHER ACTION**  
See paragraph 2 below

International application No.  
PCT/RU2006/000152

International filing date (day/month/year)  
30.03.2006

Priority date (day/month/year)

International Patent Classification (IPC) or both national classification and IPC  
INV. G06F9/45

Applicant  
INTEL CORPORATION

1. This opinion contains indications relating to the following items:

- ☒ Box No. I Basis of the opinion
- ☐ Box No. II Priority
- ☐ Box No. III Non-establishment of opinion with regard to novelty, inventive step and industrial applicability
- ☐ Box No. IV Lack of unity of invention
- ☒ Box No. V Reasoned statement under Rule 43bis.1(a)(i) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement
- ☐ Box No. VI Certain documents cited
- ☐ Box No. VII Certain defects in the international application
- ☐ Box No. VIII Certain observations on the international application

2. **FURTHER ACTION**

If a demand for international preliminary examination is made, this opinion will usually be considered to be a written opinion of the International Preliminary Examining Authority ("IPEA") except that this does not apply where the applicant chooses an Authority other than this one to be the IPEA and the chosen IPEA has notified the International Bureau under Rule 66.1bis(b) that written opinions of this International Searching Authority will not be so considered.

If this opinion is, as provided above, considered to be a written opinion of the IPEA, the applicant is invited to submit to the IPEA a written reply together, where appropriate, with amendments, before the expiration of 3 months from the date of mailing of Form PCT/ISA/220 or before the expiration of 22 months from the priority date, whichever expires later.

For further options, see Form PCT/ISA/220.

3. For further details, see notes to Form PCT/ISA/220.

Name and mailing address of the ISA:



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Date of completion of  
this opinion

see form  
PCT/ISA/210

Authorized Officer

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**WRITTEN OPINION OF THE  
INTERNATIONAL SEARCHING AUTHORITY**

International application No.  
PCT/RU2006/000152

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**Box No. I Basis of the opinion**

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1. With regard to the **language**, this opinion has been established on the basis of:
  - ☒ the international application in the language in which it was filed
  - ☐ a translation of the international application into , which is the language of a translation furnished for the purposes of international search (Rules 12.3(a) and 23.1 (b)).
2. With regard to any **nucleotide and/or amino acid sequence** disclosed in the international application and necessary to the claimed invention, this opinion has been established on the basis of:
  - a. type of material:
    - ☐ a sequence listing
    - ☐ table(s) related to the sequence listing
  - b. format of material:
    - ☐ on paper
    - ☐ in electronic form
  - c. time of filing/furnishing:
    - ☐ contained in the international application as filed.
    - ☐ filed together with the international application in electronic form.
    - ☐ furnished subsequently to this Authority for the purposes of search.
3. ☐ In addition, in the case that more than one version or copy of a sequence listing and/or table relating thereto has been filed or furnished, the required statements that the information in the subsequent or additional copies is identical to that in the application as filed or does not go beyond the application as filed, as appropriate, were furnished.
4. Additional comments:



**WRITTEN OPINION OF THE  
INTERNATIONAL SEARCHING AUTHORITY**

International application No.  
PCT/RU2006/000152

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**Box No. V** Reasoned statement under Rule 43*bis*.1(a)(i) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

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1. Statement

Novelty (N)	Yes: Claims	1-39
	No: Claims	
Inventive step (IS)	Yes: Claims	1-39
	No: Claims	
Industrial applicability (IA)	Yes: Claims	1-39
	No: Claims	

2. Citations and explanations

see separate sheet

Re Item V

Reasoned statement with regard to novelty, inventive step or industrial applicability:  
citations and explanations supporting such statement

1. Reference is made to the following documents:

D1: DATABASE INSPEC [Online] THE INSTITUTION OF ELECTRICAL ENGINEERS, STEVENAGE, GB; March 1996 (1996-03), ANDERSSON N ET AL: "Overview and industrial application of code generator generators" XP002412956 Database accession no. 5215711

D2: US-B1-6 247 174 (SANTHANAM VATSA [US] ET AL) 12 June 2001 (2001-06-12)

D3: WO 92/15941 A (DIGITAL EQUIPMENT CORP [US]) 17 September 1992 (1992-09-17)

2. The document D1 is regarded as being the closest prior art to the subject-matter of claim 1, and shows (the references in parentheses applying to this document):

A code generation method (page 185, right-hand column, lines 37 to 39) comprising:

- having a table of pattern (collection of rules in figure 3) comprising a DAG representing multiply and add operations (figure 3, and page 186, left-hand column, lines 26 to 34),
- matching incoming expressions against the table of pattern during the compilation of a program (page 186, left-hand column, lines 26 to 34, page 188, right-hand column, lines 1 to 23 where the rules are the table of patterns).

The subject-matter of claim 1 differs from this known D1 in that the table of pattern is generated, it comprises an FMA DAG, a canonical form equivalent of the FMA DAG and a shape corresponding to the canonical form equivalent, and the floating-point expressions are matched against the patterns.

The subject-matter of claim 1 is therefore new (Article 33(2) PCT).

The problem to be solved by the present invention may be regarded as how to decrease the time needed to perform an optimisation of floating-point expressions present in a source code.

The solution to this problem proposed in claim 1 of the present application is considered as involving an inventive step (Article 33(3) PCT) for the following reasons:

The document D1 deals with simple ADD instructions and never refers to the optimisation for the specific case of the FMA instructions; moreover, D1 stays silent about the *generation* of a table of patterns but refers to rules that are defined once and not when making a code generation. Even if the document D2 deals with the optimisation of source code containing FMA instructions (column 18, lines 22 to 40), it never mentions a pattern matching and pattern table generation to perform this optimisation but rather use inlining of low level instructions with type transformation. The document D3 describes a compiler using pattern matching to select a code template optimising the code (page 39, lines 8 to 25) and also uses an intermediate language representing the expressions using a DAG in order to analyse the operator-operand structure (page 48, lines 11 to 26) but does not refer to the generation of the pattern table. None of the documents refers to the use of a shape corresponding to the canonical form of the DAG.

3. The subject-matter of claim 17 is the same as the subject-matter of claim 1, written as an article and is inventive for the same reasons.
4. The document D3 is regarded as being the closest prior art to the subject-matter of claim 33, and shows (the references in parentheses applying to this document):
  - A code generation system comprising :
    - a processor
    - a memory comprising a code generator (page 7, lines 4 to 15 where a compiler is a code generator) having an optimiser and associated table of patterns (figure 1 and page 39, lines 8 to 25 where the matching with a pattern makes unambiguous the table of patterns).

The subject-matter of claim 33 differs from this known D3 in that the processor comprises fused instructions, the code generator comprises a floating-point module, receives a floating point expression and generates a sequence of optimal FMA, FMS or FNMA instructions to compute the expression.

The subject-matter of claim 33 is therefore new (Article 33(2) PCT).



The problem to be solved by the present invention may be regarded as how to reduce the computing time of a compiled floating point expression.

The solution to this problem proposed in claim 33 of the present application is considered as involving an inventive step (Article 33(3) PCT) for the following reasons: The document D1 to D3 fails to disclose such an optimisation of floating-point expressions. Even if the document D2 discloses the optimisation of floating-point expressions, it never finds an optimal set of fused instructions but rather introduces inlined low level instructions in the source code (column 3, lines 6 to 12).

5. Claims 2 to 16, 18 to 32 and 34 to 39 are dependent respectively on claims 1, 17 and 33 and as such also meet the requirements of the PCT with respect to novelty and inventive step.

